European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

INTERNATIONAL WG1-WG4 MEETING on

New Sensing Technologies and Methods for Air-Pollution Monitoring

European Environment Agency - EEA

Copenhagen, Denmark, 3 - 4 October 2013

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 2: 2013-2014 (*Ongoing Action*)

Identifying Sources to Aeroallergens in Urban Areas by Unmanned Airborne Vehicles (UAV)

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Function in the Action: (WG Member (since September 2013)

National Pollen and Aerobiology Research Unit, University of Worcester/ United Kingdom

COST is supported by the EU Framework Programme

ESF provides the COST Office through a European Commission contract

Scientific context and objectives

- **Background / Problem statement:**
  - Seasonal Allergic Rhinitis reduce quality of life
  - Seasonal Allergic Rhinitis is expensive
    - In some countries total costs exceed costs of Asthma
  - One of the most common causes is birch (*Betula*) pollen
    - Little is known about oak (*Quercus*) and alder (*Alnus*)
    - Sensitisations: *Betula* (25%), *Quercus*(20%), *Alder*(?)
  - Considerable cross reactivity between families of trees
  - Considerable effects of co-exposure of air pollution
  - Known effects on chemicial transformation of allergens in pollen

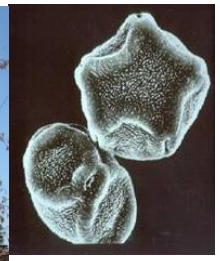
Scientific context and objectives

- **Brief reminder of objectives:**
  - Studies on new sensor systems (WG2/WG3)
  - Development of air quality modeling (WG3)
  - Environmental observations of bioaerosols (WG3)

Scientific context and objectives

- **Background / Problem statement: The target**

***Alnus* (alder) pollen**
allergenic potential 4 (scale 1-5)

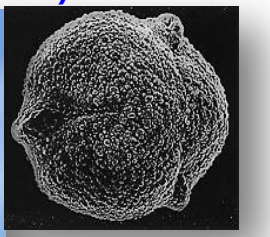


Size: ~ 25 um
Season (Worcester): March-April

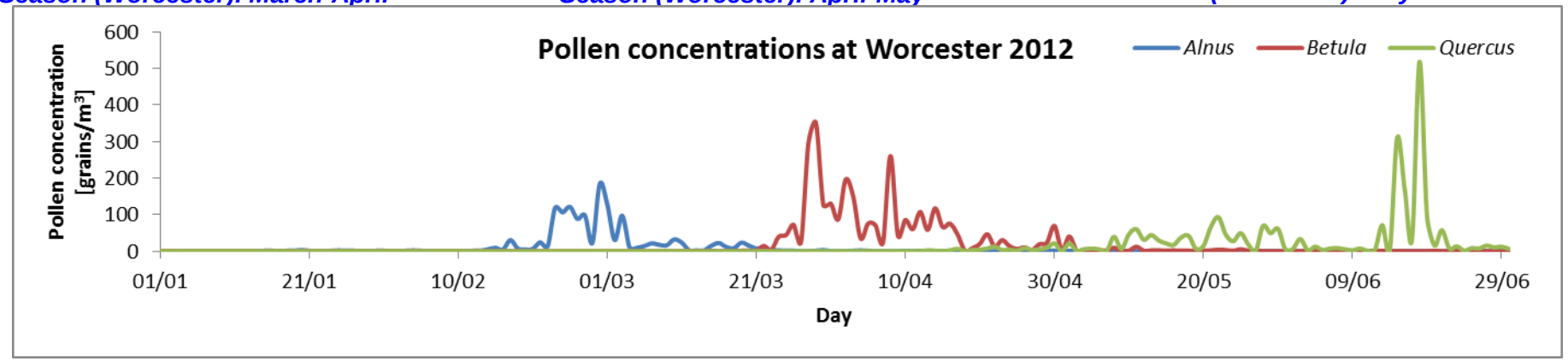
***Betula* (birch) pollen**
allergenic potential 5 (scale 1-5)

Size: ~ 20 um
Season (Worcester): April-May

***Quercus* (oak) pollen**
allergenic potential 4 (scale 1-5)



Size: ~ 30 um
Season (Worcester): May-June



Current activities of the partner

- Pollen/spore research, monitoring and forecasting

Spatial analysis of pollen emissions

Start, duration and severity of pollen & spore seasons

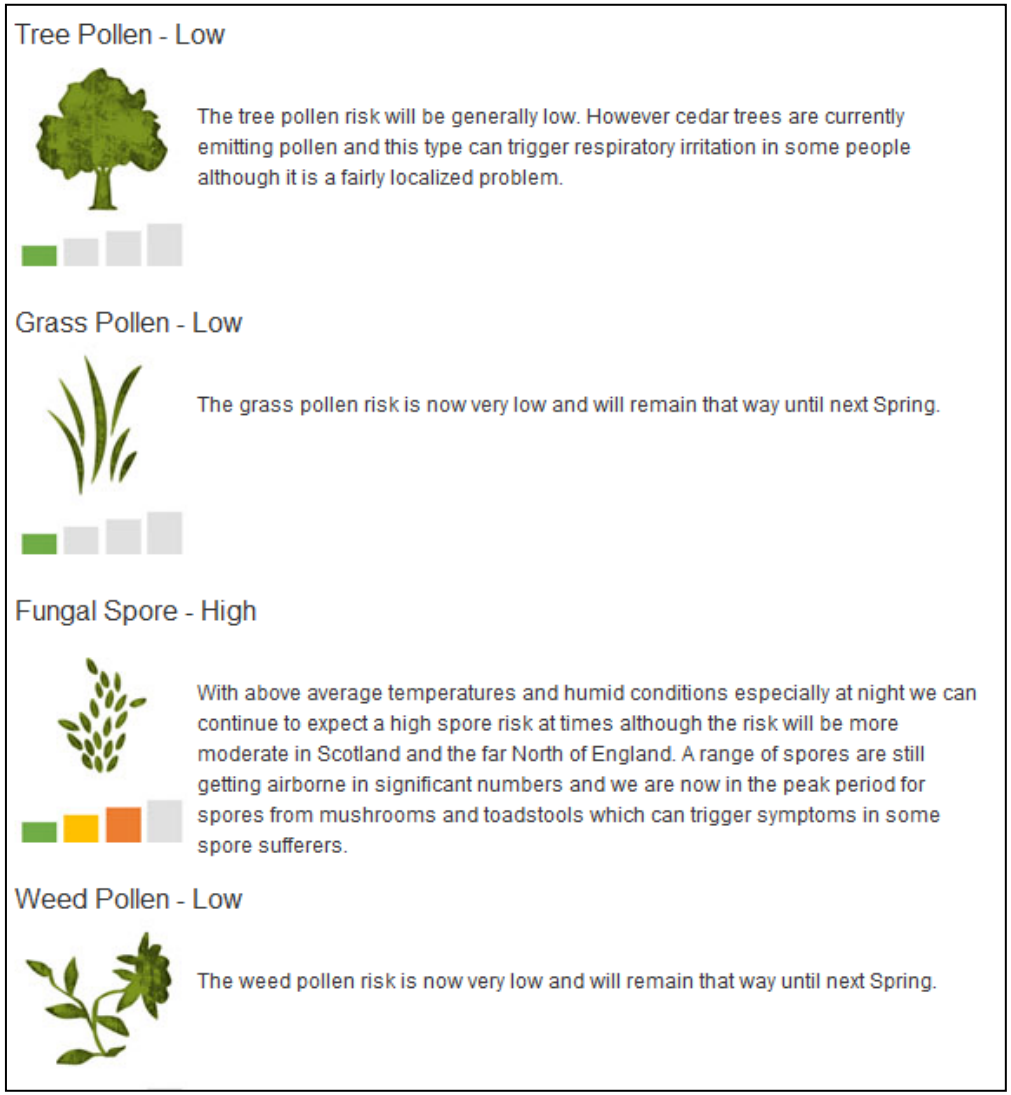
Current activities of the Partner (1/2)

- **Pollen/spore research, monitoring and forecasting**

Pollen, spore and weather monitoring

Current activities of the Partner (1/2)

- **Pollen/spore research, monitoring and forecasting**



Key provider of quality pollen and spore forecasts

Current activities of the Partner (1/2)

- **Crop protection research: spore pathogen detection methods and forecasting**

Current activities of the Partner (1/2)

- **Plant Science**

Research into host-pathogen interactions using latest technologies to overcome future crop challenges

Facilities available for the Partner (2/2)

- **Research/Measurement/Service Facilities:**
- Long time series of observed bioaerosols (pollen and fungal spores)
- Environmental chamber + GCMS
- Good range of bioaerosol sampling equipment
- High quality laboratories (from 2010) and experienced staff
- Atmospheric models and own computing facilities
- Extended permission to use UAVs
- Rotary wing UAV (existing permission) and from 2014 a fixed wing UAV, designed for remote sensing and airborne sampling

Facilities available for the Partner (2/2)

- **Environmental chamber**

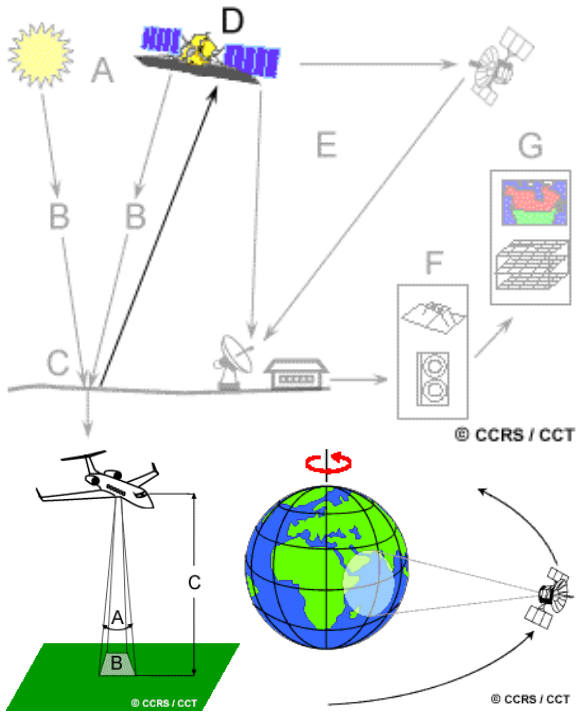
Large capacity but can be divided into smaller units

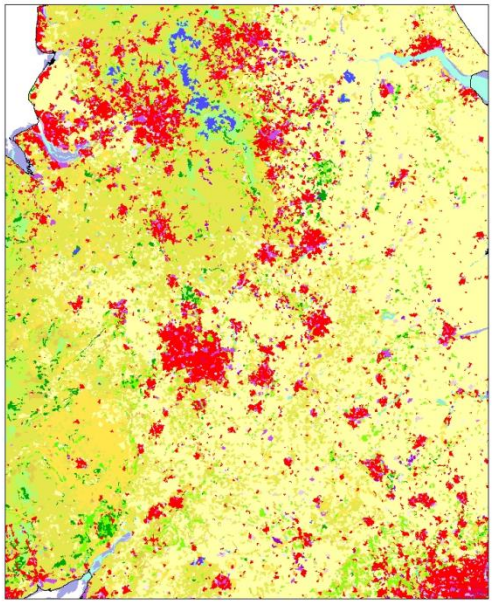
Most atmospheric parameters can be controlled

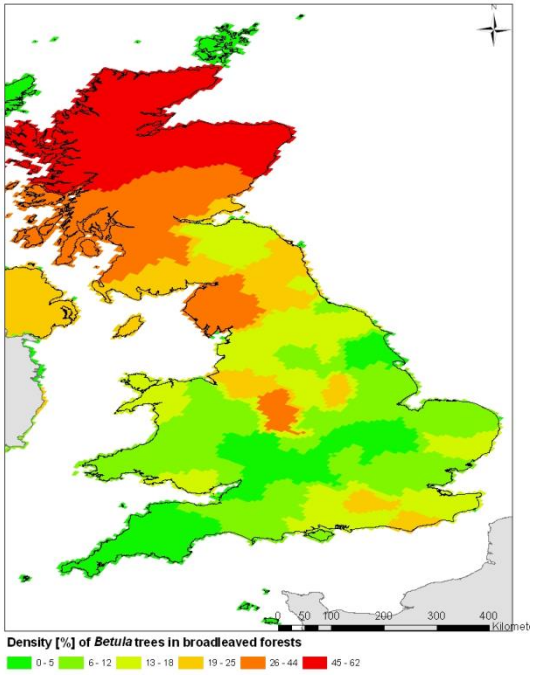
Research or commercial product testing

Achieved RESULTS and future activities

- **Activities directions as RESULTS:**
- Innovative source maps for the UK using known methods



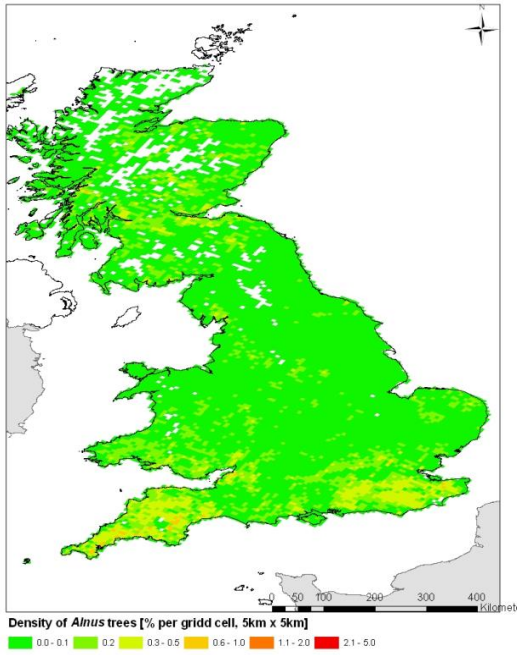




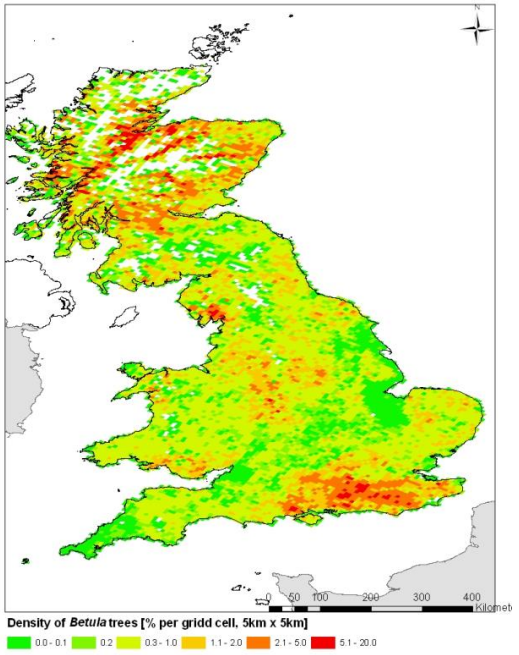
Achieved RESULTS and future activities

- **Activities directions as RESULTS:**
- Innovative source maps for the UK using known methods

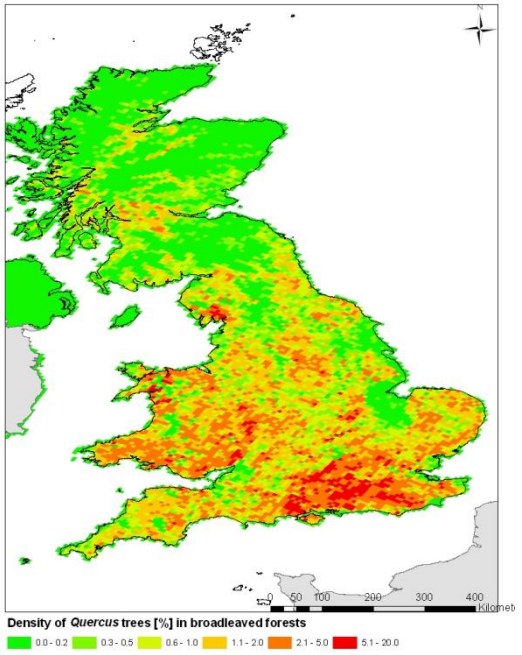
The density of woodland areas with either a) *Alnus*, b) *Betula* or c) *Quercus* trees by using woodland statistics and official survey data for the UK. Note the different legend on the three maps.



Mean Seasonal Pollen Index (SPI): 1397
Amount of *Alnus* trees (km2): 1500



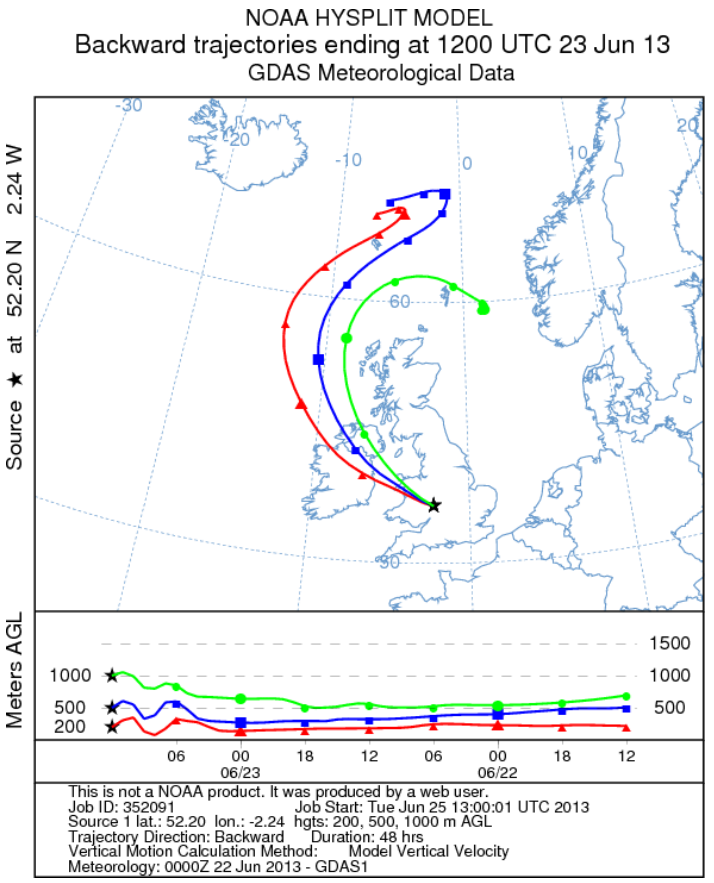
Mean Seasonal Pollen Index (SPI): 3618
Amount of *Betula* trees (19000)



Mean Seasonal Pollen Index (SPI): 3895
Amount of *Quercus* trees (km2): 27000

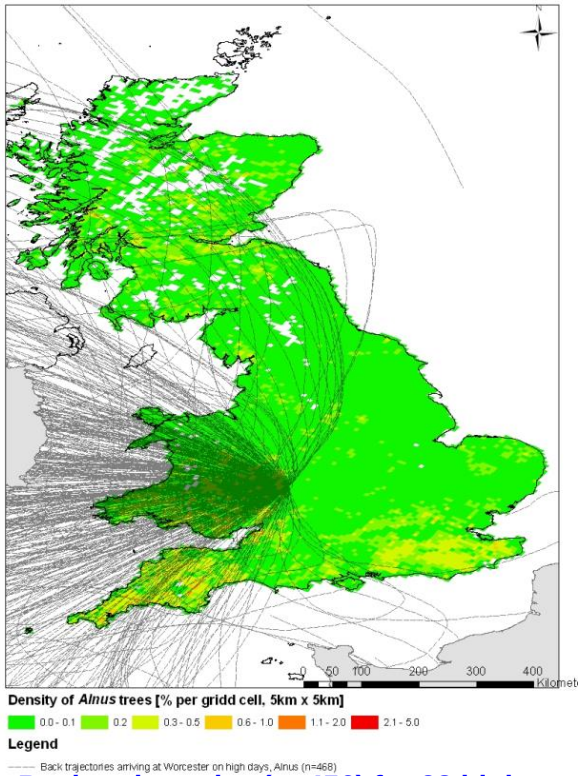
Achieved RESULTS and future activities

- **Activities directions as RESULTS:**
- An innovative method for analysing atmospheric transport in GIS framework
- Example: A trajectory model
- Simulate atmospheric transport using eq. from atmospheric physics
- Idea: Simulate path of one (or many) particles
- Typical input: Wind speed, wind direction, temperature, humidity, pressure
- Can go forward or backward

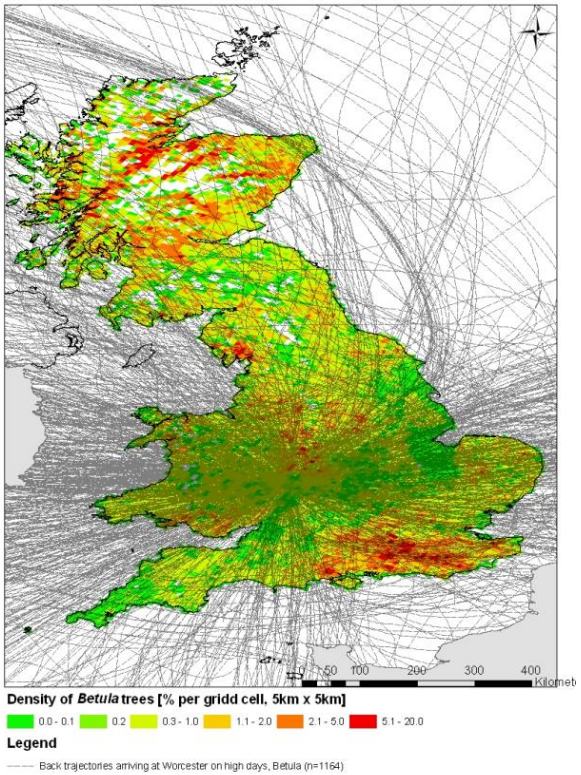


Achieved **RESULTS** and future activities

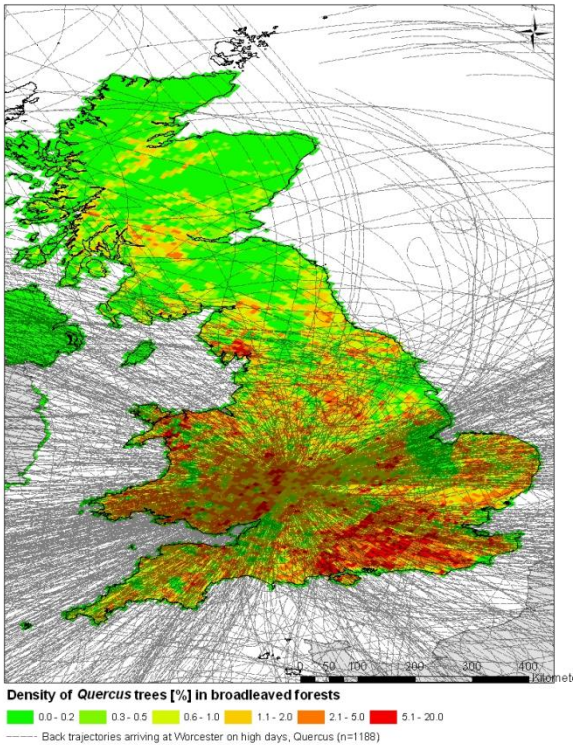
- **Activities directions as RESULTS:**



Back trajectories (n=456) for 38 high days of *Alnus* (alder) pollen



Back trajectories (n=1164) for 97 high days of *Betula* (birch) pollen



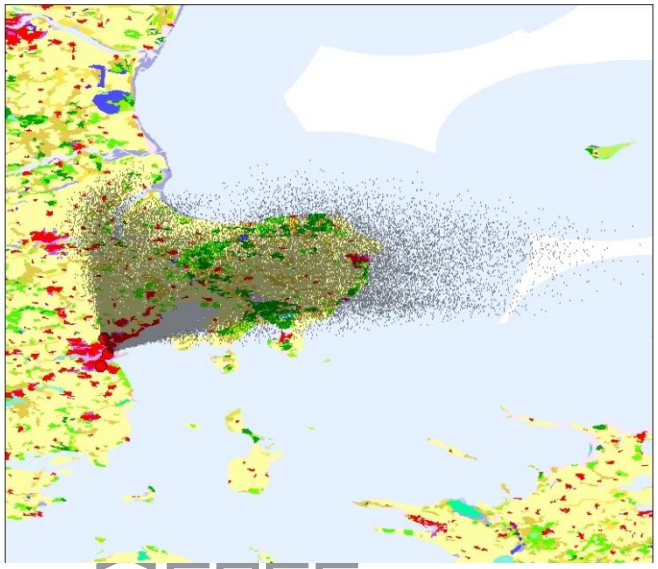
Back trajectories (n=1284) for 107 high days of *Quercus* (oak) pollen

Future planned Activities

- **Activities directions as future ACTIVITIES:**
- Advanced spatial modelling bioaerosols (pollen, spores)
  - Neural Network Methods
  - Receptor based modelling (trajectories+particle dispersion models)
  - Source based modelling (WRF-Chem)
  - Dynamic Modelling of Chemistry and Biology. Focus on climate driven emissions
  - Use of UAVs for remote sensing in urban areas (2014-15, the SUPREME project)
- Improvement of current forecast products for the UK
- New applications for further development of UAVs as an generic platform for small sensors (1 application under evaluation)

Future planned Activities

- **Activities directions as future ACTIVITIES:**
- 1. Use of UAVs and Atmospheric Modelling on bioaerosols
  - Planning of urban campaigns in 2014-15, training in using UAV
- 2. Use of WRF-Chem in relation to bioaerosols and climate driven emissions (especially ammonia and BVOCs)
- 3. Use of particle dispersion models



1. Funded by Danish Research Council (DRC)
2. Funded by DRC & commercial contracts on pollen forecasts
3. Funded by DRC & University of Worcester

CONCLUSIONS

- **CONCLUSIONS:**
- Sources to bioaerosols:
  - Novel maps of bioaerosols and a methods for using GIS data with atmospheric models
  - Sources found in remote areas but Long Distance Transport is episodic
  - An important source to bioaerosols remains to be identified
  - Urban and near areas are likely to the main source!
- Open problems – mainly related to modelling and use of UAVs
  - Limitations in modelling are unknown, biological processes are stochastic
  - Use of UAVs are restricted despite an extended permission to University of Worcester
  - Experience on the use of UAV as a tool in environmental science is very limited -> learn as you go